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Interventions to improve hand hygiene compliance in patient care:
reflections on three systematic reviews for the Cochrane
Collaboration 2007-2017

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Abstract

This article presents highlights from a recently updated systematic Cochrane review evaluating the effectiveness of interventions to improve hand hygiene compliance in patient care. It is an advance on the two earlier reviews we undertook on the same topic as it has for the first time provided very rigorous [synthesis of evidence](#) that such interventions can improve practice. [In this article](#) we provide [highlights from a recently updated Cochrane systematic review](#). We [identify omissions in the information reported and point out important aspects of hand hygiene intervention studies that were beyond the scope of the review](#). A full report of the review is available free of charge on the Cochrane website.

Healthcare-associated infection is a major cause of morbidity and mortality. It is a costly burden to health services, a source of concern to patients and the public and is currently receiving priority from policy-makers because it contributes to the global threat of antimicrobial resistance (Health Foundation 2015). Hand hygiene is widely regarded as an important preventative measure [but it is difficult to increase compliance and even more difficult to ensure that improvement is sustained \(Gould et al 2017a\)](#). This article summarises highlights from a recently updated Cochrane systematic review. We also identify omissions in the information reported and point out important aspects of hand hygiene intervention studies that were beyond the scope of the review.

History of the review

In 2006 our team [in conjunction with the Cochrane Collaboration undertook](#) a systematic review of the literature to explore evidence of the effectiveness of interventions to improve hand hygiene compliance in patient care. Reporting in 2007, the review identified forty potentially eligible publications. Only two met the stringent inclusion criteria required by our Cochrane group, which is the Effective Practice and Organisation of Care (EPOC) Group [based in the Nuffield Department of Population Health at Oxford University](#). Applying their extremely rigorous methodology, evidence of the effectiveness of hand hygiene was equivocal. A randomised controlled trial undertaken in one hospital in the People's Republic of China (Huang et al 2002) demonstrated that an educational intervention could increase hand hygiene. The other study, a non randomised trial in four surgical wards in a London teaching hospital, suggested that ward-based teaching with practical demonstrations of hand hygiene did not increase compliance (Gould and Chamberlain 1997). Neither of the studies was considered to be very robust and both were associated with a number of additional shortcomings. Both were small scale, restricted to a single professional group (nurses) and failed to explore the impact of hand hygiene on infection rates. Given the importance of the topic and the attention that infection prevention was receiving, we updated [the work](#) two years later.

By 2009 the number of potentially eligible publications had doubled but the quality of the studies had not progressed. Only two additional pieces of research were sufficiently rigorous to include. One was an interrupted times series study undertaken in northern Europe (Vernaz et al 2008), the other an interrupted time series study from Australia (Whitby et al 2008). In both cases, a campaign

promoting an alcohol-based hand hygiene product combined with education increased compliance. One of these studies [also](#) investigated the impact of hand hygiene on infection rates (Vernaz et al 2008). Meticillin-resistant *Staphylococcus aureus* (MRSA) infection declined but infections caused by *Clostridium difficile* did not, unsurprisingly, as alcohol is ineffective against its spores which can survive in the environment for a long time.

The second update

The second update of the review was published in September 2017 (Gould et al 2017b). In the intervening years much has happened in the world of infection prevention, especially hand hygiene [and the review was on the Cochrane Collaboration's priority list \(<http://community.cochrane.org/review-production/production-resources/prioritization-list-project>\)](#).

In 2009, just after publication of the [first](#) update of the review, the World Health Organization (WHO) (2009) published its guidelines for hand hygiene. These have since been introduced in many countries (Mathai et al 2011). The guidelines promote a multimodal strategy based on the successful approach originally adopted in the University Hospital Geneva (Pittet et al 2000). [Multimodal interventions intended to be adapted to local need involve the introduction of](#) an alcohol-based hand hygiene product, education, written and/or verbal reminders with performance feedback and administrative support. The guidelines incorporate the Five Moments for Hand Hygiene (Sax et al 2007).

The volume of new evidence

Interest in interventions intended to promote hand hygiene compliance escalated between 2009 and 2017. Searches identified 534 potentially eligible full text studies. It was possible to include 23 new ones in the review. These were added to three from the original review and the first update. One of the older studies (Gould and Chamberlain 1997) was no longer eligible because the EPOC criteria have been updated, the inclusion criteria are even more rigorous than before and the study no longer meets them.

What the new evidence adds to the body of knowledge

The study designs are shown in Table 1. We could not pool the data in meta-analysis because they were too different for the results of combined analysis to be meaningful. [Different outcome measures were used including observed compliance and volume of product consumed, reported in different units of](#)

measurement. Furthermore some studies were conducted in hospitals, others in long-term care facilities and one took place in primary care. Data were collected from a range of different healthcare workers. Fourteen studies presented the findings of multimodal campaigns featuring complex interventions that were either similar to, or based on the WHO guidelines (see Table 2). Of the remaining studies, six focused on performance feedback with additional components (Armellino et al 2012, Fisher et al 2013, Fuller et al 2012, Stewardson et al 2016, Moghnieb et al 2016, Talbot et al 2013). Two studies evaluated education (Huang et al 2002, Higgins et al 2013), three studies evaluated cues such as signs or scent (Grant and Hoffman 2011, Diegel-Vacek and Ryan 2016, King et al 2016) and one study assessed positioning of alcohol-based product in the clinical area (Munoz-Price et al 2014).

The second update shows that multimodal interventions to increase hand hygiene compliance and single interventions based on their individual components probably can increase hand hygiene compliance *but improvement was at best modest and there was considerable variation in the results between studies and within the same study between different wards and centres*. Only nine studies reported rates of infection or colonisation (Derde et al 2014, Ho et al 2012, Lee et al 2013, Mertz et al 2010, Perlin et al 2013, Stevenson et al 2014, Stewardson et al 2016, Vernaz et al 2008, Yeung et al 2011). These demonstrated that hand hygiene may slightly reduce infection or colonisation.

Quality of the new evidence

The major drawback of any study evaluating hand hygiene is that it is impossible to conceal the nature of the intervention or the purpose of hand hygiene monitoring from health workers. While this situation will never be easy to control there were other problems that could easily have been avoided. *Statistical analysis was conducted inappropriately in some of the studies and in another otherwise well-conducted study data analysts knew whether health workers had been allocated to the test or control group and this could have influenced findings* (Yeung et al 2011).

We concluded that there is an urgent need to conduct methodologically robust research to explore the effectiveness of multimodal interventions versus simpler interventions to increase hand hygiene compliance and identify which components of multimodal interventions or combinations of strategies are most effective in a particular context. The findings would avoid wasteful use of

resources to implement an intervention or parts of an intervention that are not effective. This information would be especially welcome in low income countries.

What the second update of the review does not tell us

In some papers there were omissions in the information reported. There are also important issues that were beyond the scope of the review.

Omissions in the information reported

Authors' failure to address the economic aspects of hand hygiene campaigns was a major omission. All hand hygiene initiatives have some associated cost, depending on the sophistication of the intervention, the method of hand hygiene monitoring and the amount of staff time required, yet cost was only considered in two studies. Talbot et al (2013) commented on the financial incentives of hospitals in the US to improve hand hygiene compliance and reduce infection rates and failure to capitalise on these advantages in their data collection sites. Grant et al (2011) identified cost savings in terms of the number of infections prevented by cleansing hands. Given the modest improvement in compliance and infection rates we identified, economic evaluation emerges as an essential component of future studies.

The ability of the intervention to change practice and sustain any resulting improvement also required greater consideration in some studies. Authors of multimodal interventions based on the Geneva work justified their interventions on its success but for those that involved additional components, the purpose of the additional intervention was not made explicit. For example, in the study by Yeung et al (2011) health workers were supplied with hand-held dispensers containing alcohol-based product. The assumption seems to have been that a portable device would increase accessibility but this was not made clear. In the study by Ho et al (2012) the effect of supplying staff with powderless disposable gloves was tested. No explanation of why they might have any effect on hand hygiene behaviour was given. One of the most methodologically robust studies (King et al 2016) tested the impact of olfactory and visual cues on hand hygiene compliance. Pervading the clinical area with a citrus scent had a modest positive impact. In another arm of the same study a poster depicting a stern pair of male eyes had more impact than a poster showing the smiling eyes of a young woman. Like all 'novelty' interventions, the impact of these interventions is likely to be short-lived. Transferability is also questionable. In other cultures different scents

might be considered 'clean' and a different facial expression might promote compliance.

Very few studies explored health workers' opinions of hand hygiene interventions. This is surprising given that so many depend heavily on education which when used as part of an intervention, is usually evaluated thoroughly. [In a recent UK-wide study health workers complained of infection prevention 'fatigue' and there were calls for initiatives to be more evidence based and prioritised on issues of contemporary importance \(Brewster et al 2016\).](#) These findings indicate that more needs to be done to keep infection prevention, including hand hygiene at the top of the clinical agenda.

In many of the papers considered for review, the intervention(s) employed to improve compliance were not described in very great detail and would be hard to replicate in another setting. The campaigns employed by Vernaz et al (2008) and Derde et al (2014) are not described at all. In other studies, educational interventions lack detail. This is not surprising given that most of the studies appeared in specialist journals aimed at infection preventionists for whom educational research is not a primary concern. The strict word limit of these journals precludes full presentation of what are often very complex interventions taking place over many years.

All the publications provided some information about the organisation(s) where the intervention was conducted but context was not generally provided in much detail. Strict word limits will again have played their part, but there were additional challenges: some of the interrupted time series studies took place in large organisations with multiple locations, defying lengthy description, while others continued for up to six years. The organisations undoubtedly changed over these long periods of time and many factors other than the intervention would have influenced hand hygiene compliance and infection rates. Extended periods of data collection were possible because hand hygiene is now audited routinely in many countries and routine surveillance is conducted for key nosocomial pathogens such as MRSA and *C.difficile*. It is possible that some of these initiatives were not originally set up as *a priori* research studies even though they were reported as such.

[Issues beyond the scope of the review](#)

Fidelity, the degree that the intervention is delivered as planned (Nelson et al 2012) was beyond the scope of the review although it is an important issue. In at least one study it is clear that fidelity was very low (Fuller et al 2012) but the authors do not reflect on how it might have affected the findings. In another study now excluded (Gould and Chamberlain 1997) the authors attributed lack of impact of the intervention to a number of factors probably related to fidelity: poor managerial support for the externally-based research team and inability to deliver teaching sessions as intended because of high workload in the clinical setting.

In our review we reported how hand hygiene was monitored but not the implications of the method and its robustness for the validity of study findings. Monitoring was by video camera in one study (Armellino et al 2012) and with an electronic device in one study (Fisher 2013). Three studies measured product uptake (Perlin et al, Vernaz et al 2008, Whitby 2008). The remainder employed direct observation. We discuss the advantages and disadvantages of each of these approaches and their implications for validity in separate publications (Gould et al 2007, Gould et al 2017a).

New ways of looking at the evidence

Over 500 hand hygiene intervention studies considered for the review could not be included because they were not of sufficient methodological rigour. But many of them still contain useful messages for the direction of future research and practice. For example Larson et al (2000) and Barrow et al (2009) provide a great deal of information about the setting in which the research took place and the type of interventions employed, accompanied by useful discussion of why they had been effective and when more work needed to be done. These studies were not presented as quality improvement (QIP) initiatives and did not adopt QIP methodology but a QIP approach might have been more appropriate than a traditional research write-up. Applying the rigorous EPOC criteria to these studies was like using the proverbial hammer to crack a nut. Given that the WHO guidelines advocate customising hand hygiene interventions to meet local need, QIP might be a good way to present future hand hygiene campaigns. Their cumulative evidence would enable us to build up 'case law' of how as well and what types of interventions are likely to be most effective in a particular context. To coin parlance from the Realist Evaluation movement (Pawson and Tilley 1997) we need to know which hand hygiene interventions work for whom, in what circumstances.

Among the things that can be learnt from updating the same review over a long period of time is that fashions in research methodology are subject to change. A study that was once considered robust enough to provide sound evidence may be reappraised and discarded because new quality criteria have been developed and it no longer meets them (Gould and Chamberlain 1997). The influential work undertaken in Geneva (Pittet et al 2000) adopted a pre/post-test design that is not methodologically robust, but the intervention was sensible and practical. This is why it has changed practice in so many countries and its great triumph.

CONCLUSION

The methodological rigour of research studies is of paramount importance but it is not the only factor that needs to be considered. The method of data collection, the ability of the intervention to result in change and its cost are also important. The studies we reviewed were intended to improve practice and the purpose of publication is to share that good practice. An important part of critical appraisal is to consider whether a study could improve local practice. For that to happen it must be practical, affordable and possible to reproduce. None of the studies we reviewed fulfils all these criteria. The ideal hand hygiene intervention study has still not been conducted.

Table 1. The included studies

Randomised controlled trials

Huang et al 2002 King et al 2016

Cluster randomised trials

Fisher et al 2013

Grant and Hoffman 2011

Ho et al 2012

Huis et al 2013

Martin-Madrazo et al 2012

Mertz et al 2010

Stevenson et al 2014

Stewardson et al 2016

Yeung et al 2011

Step wedged cluster randomised controlled trials

Fuller et al 2012

Rodriguez 2015

Randomised trial with cross-over

Munoz-Price et al 2014

Non-randomised trials

Diegel-Vacek and Ryan 2016

Moghnieh et al 2016

Interrupted time series studies

Armellino et al 2012

Derde et al 2014

Higgins et al 2013

Lee et al 2013

Midturi et al 2015

Perlin et al 2013

Rosenbluth et al 2015

Talbot 2013

Vernaz et al 2008

Whitby et al 2008

Table 2 Types of multimodal study

Studies not containing all the WHO elements

Ho et al 2012

Lee et al 2013

Martin-Madrazo et al 2012

Rodriguez et al 2015

Yeung et al 2011

Studies based on the WHO

Derde et al 2014

Mertz et al 2010

Perlin et al 2013

Studies based on the WHO with additional intervention

Huis et al 2013

Midturi et al 2015

Rosenbluth et al 2015

Stevenson et al 2014

Other multimodal studies

Vernaz et al 2008

Whitby et al 2008

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References

Armellino D, Hussain E, Schilling ME, Senicola W, Eichorn A, Dlugacz Y, Farber BF. (2012). Using high-technology to enforce low-technology safety measures: The use of third-party remote video auditing and real-time feedback in healthcare. *Clinical Infectious Diseases* 54: 1-7.

Barrow B, Mehler C, Price A (2009). A communications campaign designed to improve and hygiene compliance and reduce infection rates. *Journal of Community Healthcare* 2 61-77.

Brewster L, Tarrant C, Dixon-Woods M (2016). Qualitative study of views and experiences of performance management for healthcare-associated infections. *Journal of Hospital Infection* 94 : 41-47.

Cochrane Community Priority List <http://community.cochrane.org/review-production/production-resources/prioritization-list-project>.

Derde LP, Cooper BS, Goossens H, Malhotra-Kumar S, Willems RJL, Gniadkowski M, Hryniewicz W, Empel J, et al. (2014). Interventions to reduce colonisation and transmission of antimicrobial-resistant bacteria in intensive care units: an interrupted time series study and cluster randomised trial. *Lancet* 14: 31-39.

Diegel-Vacek L, Ryan C. (2016). Promoting hand hygiene with a lighting prompt. *HERD* 10: 65-75.

Fisher, DA, Seetoh T, Oh May-Lin H, Viswanathan S, Toh Y, Yin WC et al. (2013). Automated measures of hand hygiene compliance among healthcare workers using ultrasound: validation and a randomized controlled trial. *Infection Control and Hospital Epidemiology* 34: 919-928.

Fuller C, Michie S, Savage J, McAteer J, Besser S, Charlett, A and Hayward, A, Cookson, BD and Cooper, BS and Duckworth, G and Jeanes, A, Roberts, J and Teare, L, Stone, S (2012). The Feedback Intervention Trial (FIT) — Improving Hand-Hygiene Compliance in UK Healthcare Workers: A Stepped Wedge Cluster Randomised Controlled Trial. **PLoS ONE**: e41617.

Gould, D.J. & Chamberlain, A. (1997). The use of a ward-based educational package to enhance nurses' compliance with infection control procedures. *Journal of Clinical Nursing*, 6, 55 - 67.

Gould, D J, Chudleigh, J, Drey, N S, Moralejo, D (2007).. Measuring handwashing performance in health service audits and research studies. *Journal of Hospital Infection* 66: 109-115.

Gould DJ, Creedon S, Jeanes A, Drey NS, Chudleigh J, Moralejo D (2017a). The Hawthorne and avoidance effects in hand hygiene practice and research: methodological reconsideration. *Journal of Hospital Infection* 95: 169-174.

Gould DJ, Moralejo D, Drey NS, Chudleigh J H, Taljaard M (2017b). Interventions to improve hand hygiene compliance in patient care (second update). *Cochrane Database of Systematic Reviews* Cochrane Database of Systematic Reviews Issue 9 Art.No. CD005186.DOI:10.1002/14651858.CD005186.pub4.

Grant, A. and Hoffman, D (201). It's not all about me: Motivating hand hygiene among health care professionals by focusing on patients. *Psychological Science* 22: 1494-99.

Health Foundation. Infection prevention and control: lessons from acute care in England. Towards a whole health economy approach. Health Foundation Learning Report. Health Foundation: 2015.

Higgins A, Hannan MM. (2013). Improved hand hygiene technique and compliance in healthcare workers using gaming technology. *Journal of Hospital infection* 84: 32-37.

Ho, M, Seto, W, Wong, L, Wong, T.(2012). Effectiveness of multifaceted hand hygiene interventions in long-term care facilities in Hong Kong: a cluster-randomized controlled trial. *Infection Control and Hospital Epidemiology* 33: 761-7

Huis A, Schoonhoven L, Grol R, Donders R, Hulscher M, van Achterberg T (2013). Impact of a team and leaders-directed strategy to improve nurses' adherence to hand hygiene guidelines: a cluster randomised trial. *International Journal of Nursing Studies* 55: 464-474.

- Huang J, Jiang D, Wang X, Liu Y, Fennie K, Burges J, William, AB. (2002). Changing knowledge, behavior and practice related to universal precautions among hospital nurses in China. *Journal of Continuing Education in Nursing* 33: 217-224.
- King D, Vlaev I, Everett-Thomas R, Fitzpatrick M, Darzi A, Birnback D. (2016). 'Priming' hand hygiene compliance in clinical environments. *Health Psychology* 35: 96-101.
- Larson EL, Early E, Cloonan, P, Surgue S, Parides, M. (2000). An organizational climate intervention associated with handwashing and decreased nosocomial infections. *Behavioral Medicine*: 26 14-22.
- Lee AS, Cooper BS, Malhotra-Kumar S, Chalfine A, Daikos GL, Fankser C et al. (2013). Comparison of strategies to reduce methicillin-resistant *Staphylococcus aureus* rates in surgical patients: a controlled multicentre interevention trial. *BMJ Open* 3: e003126.
- Mathai E, Allegranzi B, Kilpatrick C, Bagheri Nejad S, Graafmans W, Pittet D. (2011). Promoting hand hygiene in healthcare through national/subnational campaigns. *Journal of Hospital Infection* 77: 294-298.
- Mertz D, Dafoe N, Walter SD, Brazil K, Loeb M (2010). Effect of a multifaceted intervention on adherence to hand hygiene among healthcare workers: a cluster-randomized trial. *Infection Contro and Hospital Epidemiology* 31: 1170-1176.
- Midturi JK, Narasimhan A, Barnett T, Sodek J, Schreier W, Barnett J et al. (2015). A successful multifaceted strategy to improve hand hygiene compliance rates. *American Journal of Infection Control* 43: 533-536.
- Moghnieb R, Soboh R, Abdullah D, El-Helou M, Al Hassan S, Ajjour L et al. (2017). Health workers' compliance to the My 5 Moments for Hand Hygiene: comparison of 2 interventional methods. *American Journal of Infection Control* 45: 89-91.
- Munoz-Price LS, Patel Z, Banks S, Aheart K, Eber S, Lubarsky DA et al. (2014). Randomized crossover study evaluating the effect of a hand sanitizer dispenser

on the frequency of hand hygiene among anesthesiology staff in the operating room. *Infection Control and Hospital Epidemiology* 35:717-720.

Nelson MC, Cordray DS, Hulleman CS, Darrow CL, Sommer E (2012). A procedure for assessing intervention fidelity in experiments testing educational and behavioral interventions. *Journal of Behavioral Health Services and Research* 39: 374-396.

Pawson, R, Tilley, N 1997. *Realistic evaluation*. Sage. London.

Perlin JB, Hickok JD, Septimus EJ, Moody JA, Engebright JD, Bracken RM. (2013). A bundled approach to reduce methicillin-resistant *Staphylococcus aureus* infections in a system of community hospitals. *Journal of Healthcare Quality* 35: 57-68.

Pittet D, Hugonnet S, Mourouga P, Sauvan V, Touveneau S, Perneger TV. (2000). Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. *Lancet* **356**: 1307-1312.

Rodriguez V, Giuffre C, Villa S, Almada G, Prasopa-Plaizier N, Gogna M et al. (2015). A multimodal intervention to improve hand hygiene in ICUs in Buenos Aires, Argentina: a stepped wedge trial. *International Journal for Quality in Health Care* 27:405-411.

Rosenbluth G, Garritson S, Green AL, Milev D, Vidarthi AR, Auerbach AD et al. (2015). Achieving success with a partnership between graduate medical education, hospital leadership and physicians. *American Journal of Medical Quality* 31: 577-583.

Sax H, Allegranzi B, Uçkay I, Larson E, Boyce J, Pittet, D. (2007) 'My five moments for hand hygiene': a user-centred design approach to understand, train, monitor and report hand hygiene. *Infection Control and Hospital Epidemiology* 67: 9-21.

Stevenson KB, Searle K, Curry G, Boyce JM, Harbarth S, Stodard GJ et al. (2014). Infection control interventions in small rural hospitals with limited resources: results of a cluster randomized feasibility study. *Antimicrobial Resistance and Infection Control* 3 10-11.

Stewardson AJ, Sax H, Gayet-Ageron A, Touveneau S, Lontin Y, Zingg W et al. (2016). Enhanced performance feedback and patient participation to improve hand hygiene compliance of health-care workers in the setting of established multimodal promotion: a single centre, cluster randomized controlled trial. *Lancet Infectious Diseases* 16: 1345-1355.

Talbot TR, Johnson JG, Fergus C, Domenico JH, Schaffner W, Davies TL et al. (2013). Sustained improvement in hand hygiene adherence: utilizing shared accountability and financial incentives. *Infection Control and Hospital Epidemiology* 34: 1129-1136

Vernaz, N., Sax, H., Pittet, D., Bonnabry, P., Schrenzel, J. Harbarth, S. (2008). Temporal effects of antibiotic use and hand rub consumption on the incidence of MRSA and *Clostridium difficile*. *Journal of Antimicrobial Chemotherapy* 63: 630-631.

World Health Organization. WHO guidelines on hand hygiene in health care. http://whqlibdoc.who.int/publications/2009/9789241597906_eng.pdf. 2009. accessed 1.1.2013.

Whitby, M, McLaws ML, Slater K, Tong E, Johnson BI. (2008). Three successful interventions in health workers that improve compliance with hand hygiene: is sustained replication possible? *American Journal of Infection Control* 36: 349-355.

Yeung WK, Tam WS, Wong TW. (2011). Cluster randomized controlled trial of a hand hygiene intervention involving pocket-sized containers of alcohol-based hand rub for the control of infections in long-term care facilities. *Infection Control and Hospital Epidemiology* 2011 32: 67-76.